Development of Multimedia Fuzzy Based Diagnostic Expert System for Integrated Disease Management in Chickpea

Sonal Dubey, R. K. Pandey, S. S. Gautam

***Abstract*— One of the most important branches of Artificial Intelligence are the expert systems. Expert systems are application oriented. . An expert system is a computer application that solves complicated problems that would otherwise require extensive human expertise. It can be operated by a less educated person or a layman in a particular field of knowledge. It uses the knowledge of the domain expert to form rules to assist in decision making depending on the inputs given by the user.**

Chickpea (Cicer arietinum L) is the second most important cool season legume crop. It is mainly grown in tropical, sub-tropical and temperate regions, as rainfed in semi arid regions. there is a tremendous scope for increasing the productivity of chickpea by reducing the production losses thereof caused by serious insect pests and diseases causing up to 100 % losses during epidemic years. . For better management of the pest, effective integrated disease and insect management techniques have to be followed for increasing crop production.

Expert systems play an important role in supporting farmers to practice effective integrated disease and insect management techniques and taking decisions on crop protection where the experts are not available. Since Fuzzy logic can effectively handle vagueness and inperfect data, it is widely used in diagnosis of diseases in agriculture. This paper describes the fuzzy expert system for integrated disease management in chickpea taking into account the environmental factors like soil moisture, temperature, soil pH, relative humidity in the first step. In the second step identification based on symptoms and photos are taken into consideration and a conclusion is drawn about the diseases attacking the crop.

***Index Terms*—, chickpea , environmental factors fuzzy expert system, integrated disease management.**

I. INTRODUCTION

Chickpea (*Cicer arietinum* L) is the second most important cool season legume crop. It is mainly grown in tropical, sub-tropical and temperate regions, as rainfed in semi arid regions. It is a rich proteins supplement for vegetarians and plays a significant role in the nutrition of the rural and urban poor in the developing world. In present scenario there is a tremendous scope for increasing the productivity of chickpea by reducing the production losses thereof caused by serious insect pests and diseases causing up to 100 % losses during epidemic years.

The insect pests and diseases extent of losses there of differs among various agro-ecological zones. Among them insects & diseases are the most serious constraint causing up to 100% losses during epidemic years. Environmental factors coupled with intensity are known to compound the occurrence and severity of the insect pest and diseases. For better management of the pest, effective integrated disease and insect management techniques have to be followed for increasing crop production. Expert systems play an important role in supporting farmers to practice effective integrated disease and insect management techniques and taking decisions on crop protection where the experts are not available.

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II. EXPERT SYSTEM

One of the most important branches of Artificial Intelligence are the expert systems. Expert systems are application oriented. The Expert Systems approach attempts to model the domain knowledge of experts in their respective areas of specialization, for example, diagnosis, planning, forecasting etc. Expert System is based on the knowledge including not only models and data, but more emphasizing on experiences of domain experts. An expert system is a computer application that solves complicated problems that would otherwise require extensive human expertise. It can be operated by a less educated person or a layman in a particular field of knowledge[1]. A classical expert system is typically made up of three main components: a knowledge base, a database and an inference engine. The *knowledge base* (or *long-term memory*) contains the expert domain knowledge for use in problem solving. It consists of well-established and documented definitions, facts, rules, judgmental information, rules of thumb or heuristics. The most popular knowledge representation schemes are semantic networks, object-attribute-value triplets, rules, frames and mathematical logic. The *database* (or *working/short-term memory*) is a temporary storage for the current state of specific problem being solved. It also stores information provided by the user about the problem and the information derived by the system. The *inference engine* uses the domain knowledge together with acquired information about a problem to provide an expert solution[2]

III. FUZZY EXPERT SYSTEM

Fuzzy logic is one of the methods of Soft Computing. Soft Computing is a computational method that is tolerant to sub-optimality, impreciseness, vagueness and thus giving quick, simple and sufficient good solutions [3]. Lotfi A. Zadeh, a professor at University of California at Berkeley was the first to propose a theory of fuzzy sets and an associated logic, namely fuzzy logic (Zadeh, 1965)[11].

A fuzzy expert system is a collection of membership functions and rules that are used to reason about data Essentially, a fuzzy set is a set whose members may have degrees of membership between 0 and 1, as opposed to classical sets where each element must have either 0 or 1 as the membership degree—if 0, the element is completely outside the set; if 1, the element is completely in the set. Fuzzy expert systems use fuzzy logic instead of classical Boolean logic and collection of membership functions and rules that are used for reasoning about data. They are oriented towards numerical processing and handles uncertain or imprecise information.

A fuzzy expert system is an expert system, which consists of fuzzification, inference, knowledge base and defuzzification subsystems (as shown in **figure 1**), and uses fuzzy logic to reason about data in the inference mechanism. While inference module consists of a set of cooperating programs that execute procedural component of expert system, knowledge base and base of facts represents passive data structures. Knowledge engineer collects knowledge from domain expert and transfers it into production rules and creates knowledge base.

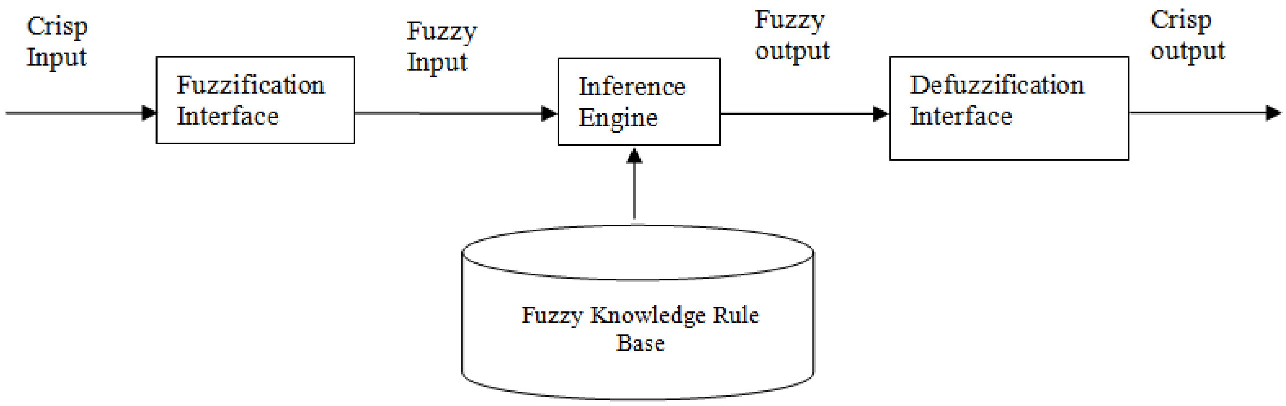


Figure 1: Basic Components of a Fuzzy Expert System.[1]

During fuzzification the input real values are transformed into linguistic values each with a membership function with a range of [0,1]. Fuzzy if-then rules and fuzzy reasoning are the backbone of fuzzy expert systems, which are the most important modeling tools based on fuzzy set theory. IF-THEN rules are applied to the terms of the linguistic variables where combinations of conditions lead to conclusions. The collection of these fuzzy rules forms the rule base for the fuzzy logic system. Using suitable inference procedure, the conclusion is drawn. This results in one fuzzy subset to be assigned to each output variable for each rule. Again, by using suitable composition procedure, all the fuzzy subsets assigned to each output variable are combined together to form a single fuzzy subset for each output variable. Defuzzification is applied to convert the fuzzy output set to a crisp output that best represents the fuzzy set. The basic fuzzy inference system can take either fuzzy inputs or crisp inputs, but the outputs it produces are always fuzzy sets. [4].

IV. REVIEW OF PREVIOUS WORK

O. C. Agbonifo D. B. Olufolaji has proposed a fuzzy expert system for treatment of diseases in maize crop. It uses the fuzzy algorithm for diagnosis of maize diseases.. It is divided into two modules, one for administer and other for the user. The system displays symptoms and user have to give input about their severity also and by making use of fuzzy the diagnosis was done.[5]

Guo-Dong You, Ji-Sheng Li, Shi-Feng Yang, Xiu-Qing Wang and Yong Hou proposed the Crop disease control fuzzy control system that uses four sensors separately detect the ambient temperature T, humidity H, light LI and CO2 concentration C. They have used BP algorithm to learn the network in the study.[6]

Fahad Shahbaz Khan , Saad Razzaq, Kashif Irfan, Fahad Maqbool, Ahmad Farid, Inam Illahi, Tauqeer ul amin have proposed a web based expert system for wheat diseases and pests. Java has been to process input and output sets. The knowledge base for e2glite expert system shell consists of simple if-then rules. The rules are usually fired on the basis of internal logic of inference engine. Forward chaining and backward chaining techniques are used.[7]

Silvia Maria Fonseca Silveira Massruhá, Raphael Fuini Riccioti, Helano Povoas Lima and Carlos Alberto Alves Meira describes the architecture of a tool called DiagData which aims to use a large amount of data and information in the field of plant disease diagnostic to generate a disease predictive system. The DiagData was used in diseases prediction and diagnosis systems and in the validation of economic and environmental indicators in agricultural production systems. Techniques of data mining were used to extract knowledge from existing data. The data was extracted in the form of rules that are used in the development of a predictive intelligent system The proposed tool DiagData, extracted knowledge automatically or semi-automatically from a database and uses it to build an intelligent system for disease prediction [8]

Shikhar Kr. Sarma, Kh. Robindro Singh & Abhijeet Singh presented the architecture, design and development of an expert system for diagnosis of diseases in the rice plant. ESTA shell was used for the design and development of the system. The architecture presented in the system is an integrated system with interactive user interface, control and coordinating units, expert system shells, and structured knowledge representations.[9]

V. DEVELOPED SYSTEM

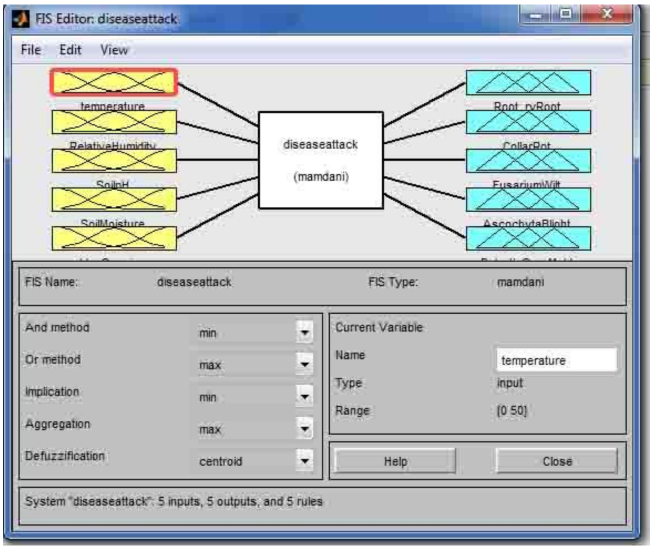
The fuzzy expert system developed for the integrated disease management of chickpea is designed on PHP and MYSQL platform. The fuzzy expert system is divided into two parts. The expert system is divided into two parts the information system and the other the diagnostic block.

The first one is the information system which gives information about all the aspects of chickpea cultivation like varieties, sowing, land preparation, pest and disease management, nutritional disorder, post harvest technology .The second part i.e the diagnostic block in which the fuzzy expert system asks the user to answer to enter inputs for temperature, soil moisture, soil pH, Line spacing and relative humidity. This is the first step of the diagnosis. The fuzzy expert system works in the following manner.

1. Fuzzification: The inputs given by the user are fuzzified using the triangular functions and fuzzy sets for temperature, soil moisture, soil pH, Line spacing and relative humidity are created. In the php program the inputs are fuzzified using the formula for triangular functions.
2. Inference Engine: The inference engine contains the knowledge base (KB) of the system. The knowledge base is created from the data gathered from domain expert, published literature, internet search, books, agriculture consultants annual reports, extension bulletins. The inference engine also contains the rule base in which rules are constructed in consultation with domain experts. The domain expert provides the confidence factor for rules and symptoms and other factors. There are 229 rules for chickpea diseases which are very harmful for the production of chickpea in recent years. Table 1 some of the rules used during the inference process.

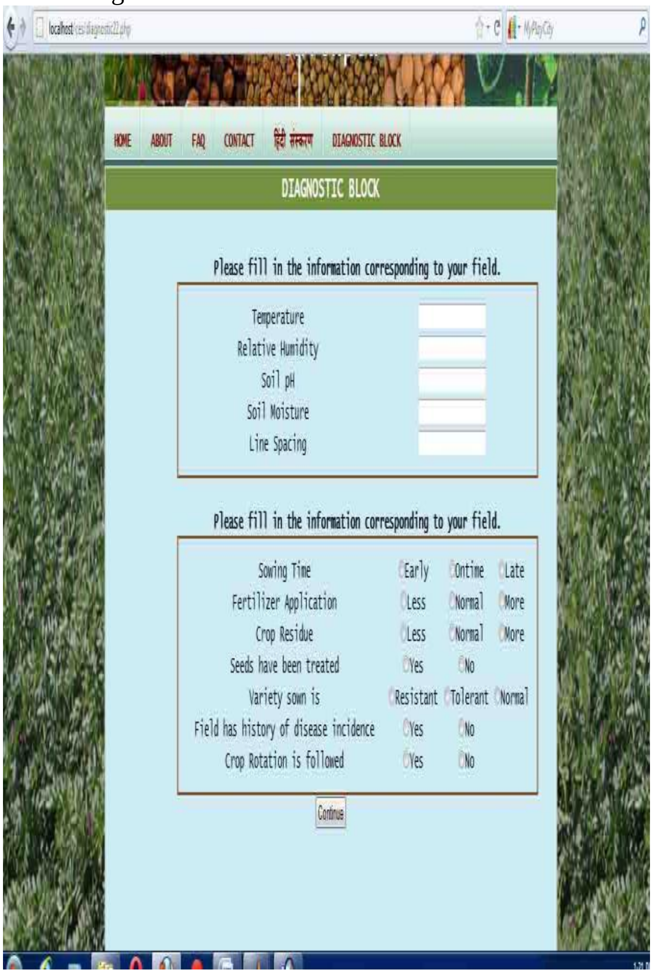
Rule No	Symptoms or Condition	Connector	Value	DiseaseName	Confidence Factor
207	Lack of pod setting	is	High	Bortrytis Grey Mold	0.9
223	Black dots, like mustard in shape on the white infected plant parts	is	High	Collar Rot	0.9
149	Crop Rotation	Is not	Followed	Fusarium Wilt	0.7
85	Line Spacing	Is	Less	Ascochyta Blight	0.8

3. The system uses Mamdani inference method to draw inferences. The last step in the inference process is to determine the degrees of truth of each linguistic term of the output linguistic variable. The maximum (MAX) of the degrees of truth of the rules with the same linguistic terms in the THEN parts is computed to determine the degrees of truth of each linguistic term of the output linguistic variable.



4. Defuzzification: The defuzzification is done by the centroid method and the output is converted into crisp value.

In the second step, the system asks the user to give input about crop rotation practices, variety sown, previous crop residue, seed treatment done, history of disease, fertilizer application and sowing time.



In the next step, the system asks the user about the parts affected. As shown in the picture

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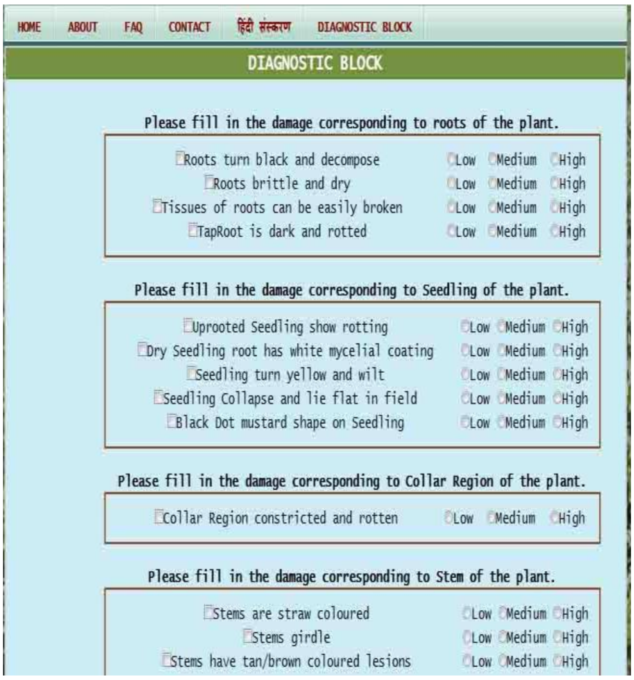
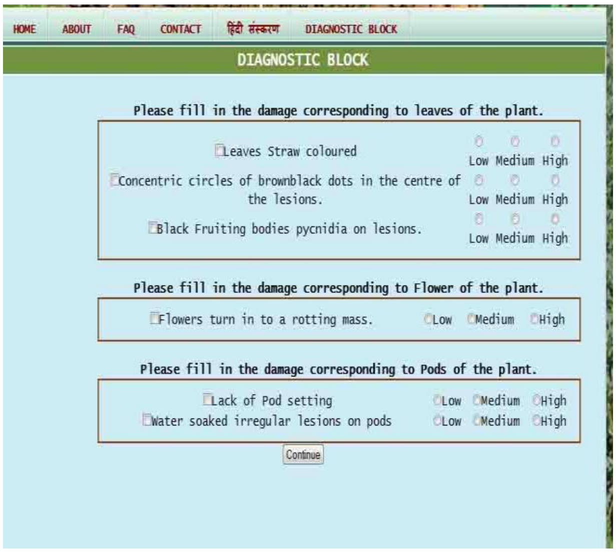
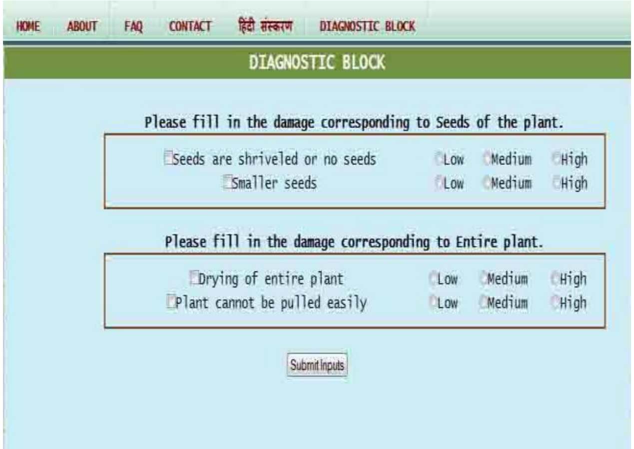
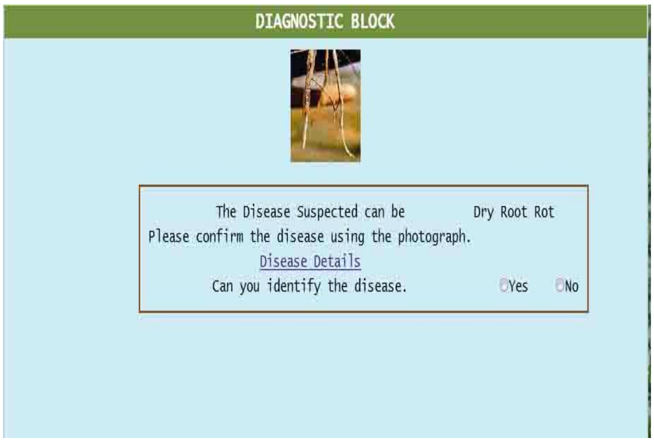
Depending upon the input selected by the user, the system shows the symptoms of the parts selected and ask the user to input the severity of the symptoms(as shown in photos).







The result of the whole inference process is then displayed. The disease attacked can be further confirmed by the user by viewing its photographs



The user can click on the Disease Details button to get information about causal organism, identification, symptoms, damage, control measures (cultural, mechanical, biological, chemical).

V. CONCLUSION

Since the present system is developed using PHP and MYSQL the system can be accessed through the internet by the farmers at their homes and decision making on various issues of chickpea production can be eased. The system is in initial stages of development in hindi language, this will facililate the Indian farmers to make better use of the software

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